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Methodology for the Integration of New Technologies into Education through Learning Based on Design Projects. Case Study

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Abstract

The beginning of the 21st century has brought about the development and evolution of Information and Communication Technologies, opening up a new paradigm in the field of knowledge.
The growth of The Fourth Industrial Revolution depends upon an education revolution. Technology introduces new possibilities for skills and abilities development in order to involve people in the future society; these consider the rise of digital fabrication as an educational tool for the integration of the creative concept within science and technology competencies, leading to debate about new and updated learning methodologies.
A design for a STEAM educational tendency-based methodology is posed in conjunction with a Project-Based Learning as a bond between technological education and the new tools, for classroom implementation. The above-mentioned methodology is put into practice by carrying out an experiment through product design. Qualitative assessment is used in order to serve as a guide for the teacher while improving the implementation of new technologies in education curriculum as well as for future directions for research.

Keywords: *New Technologies, PBL, STEAM, Education, Science, Digital Fabrication;*

1. Introduction

In recent times technological changes and the emergence of new technologies in every social sphere have modified the way information and communication is accessed among ourselves, leading to new possibilities of research and innovation within the education system.
From a pedagogical approach, new Information and Communication Technologies (ICT), have favoured the use of new resources and tools among teaching staff, encouraging in that way the curricular development of learner's digital abilities and guaranteeing a complementary academic training during the education process.
The idea that new technologies favour knowledge acquisition which leads to the ability of its proficient managing is being empowered, and therefore it is causing a context in which society starts to talk about Learning and Knowledge Technologies (LKT); this situation leads to propose a new educational paradigm. Moya [1] stated that 'these ICT and LKT have opened a new paradigm where teachers and education systems must reconsider new learning spaces and original educational content and therefore new methodologies that influence teaching-learning processes'.
Speaking of the education system in Spain, place where this research and case study are carried out, the statement above cannot be satisfied. According to Carneiro et al. [2], there is a lack of qualified teachers on using new technologies; this fact directly influences the student.
Most of educators hold that science-related disciplines are the one who allow students to recognize their environment and also to adapt to this new society. But to perform an education based on technology, this should be applied with a methodological and a practical meaning.

2. Theoretical framework

New digital fabrication tools allow student to experiment with knowledge through a Project-Based Learning (PBL), developing this way abilities such as creativity, critical thinking, cognitive skills, problem solving skills, et cetera.
PBL is presented as a learning model, where students devise, develop and experiment projects, which are applied in the daily life [3].

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This proposal is based on constructivist theories. Learning is focused on the student, and is the student who acquires knowledge throughout the communication with other students and the experience achieved.

According to Cascales et al. [4], PBL is the strategy chosen by numerous educational institutions to give response to the insertion of new tools and the necessity of facing the new education framework.

García [5] suggests that the establishment of this strategy within 'Technology' subject is fundamental, because this is characterized by being an interdisciplinary unit where knowledge, technical skills and scientific, aesthetic and communicative abilities are applied.

In order to satisfy constant technological changes, it appears the need of creating new methods for the integration of a multidisciplinary education [6]. This union of disciplines and new technologies is developed under an educational tendency named STEAM (Acronym of Science, Technology, Engineering, Art and Mathematics).

The Horizon report 2017 [7], identifies and describes at an international level which technologies and education tendencies are meant to lead over the next few years. This report presents the rise of STEAM education and encourages children for the study of science, technology and art as a creative element.

According to Maeda [8] and supported by Rhode Island Design School and Martínez [9], art is understood like a design process, and this must be placed as the creative component between science and technology.

In order to fulfil this learning process, the Horizon report 2017 [7] forecasts the use of digital fabrication and 3D printing as essential learning tools. Consequently, new 'Makerspaces' named learning spaces appear; these have multiplied by 14 over the last 10 years, reaching 1400 worldwide spaces in 2016 [7]. Skills' development through new technologies is fomented. Using design as a basis, students experiment processes for the devising and fabrication of an object for its use in real life.

Through a PBL, learners will be able to develop a final product [10]. Digital fabrication allows to design, construct and experiment diverse tasks from a multidisciplinary approach, based on STEAM.

3. Methodological development

Txikitech is founded in 2015 to develop the project "Engineering for children". It is located in Bilbao, Spain. It is formed as a research and development center to integrate new technologies into the educational curriculum. The need to incorporate a supplementary technological and scientific training based on the regulated education with a high percentage of students was identified. The project was focused on various national and international investigations and studies with educational, technological and engineering nature.

This research studies and puts into practice the use of new technologies as a learning tool. The aim is to make a qualitative evaluation through analysis in order to obtain results. Thanks to those, new objectives and short-term investigation lines are considered to be investigated, analyzed, experimented and applied afterwards.

For its fulfilment, the integration of digital fabrication under a STEAM multidisciplinary approach is outlined (Fig.1.). Learning is developed through a PBL based on the design process of a product. Students invent, develop and experiment projects that are applied in everyday life.

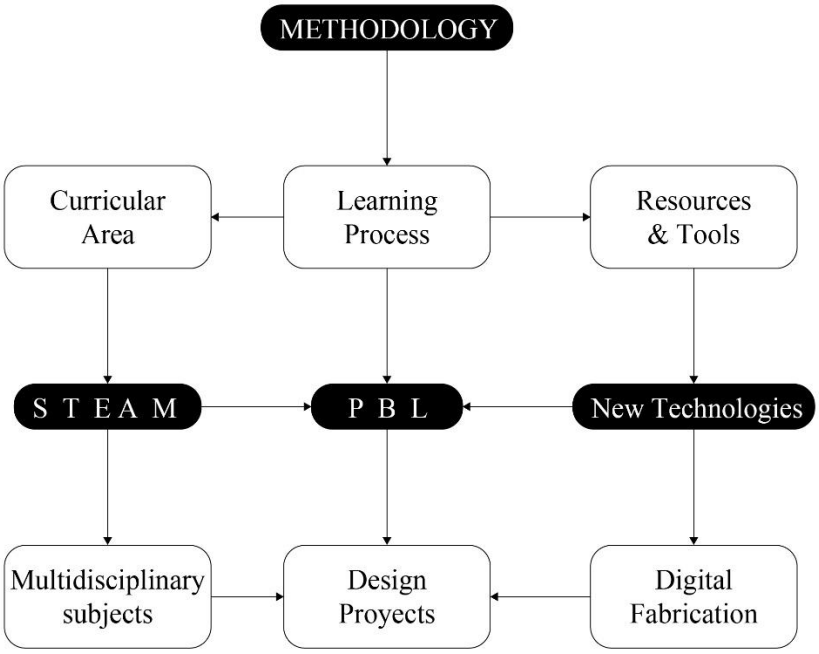

Fig. 1. Methodological approach.

4. Methodological intervention. Case studies

The application of this methodology is developed in the school Txikitech with involvement of 97 children aged between 10 and 14 during the school year 2017. Students are divided in groups with a maximum of 15 people. Each group makes an individual project divided in 6 sessions with a length of 6 hours.

The case study consists of the design of a physical object starting with the idea until its manufacturing and presentation following a PBL based in design (Fig. 2.).

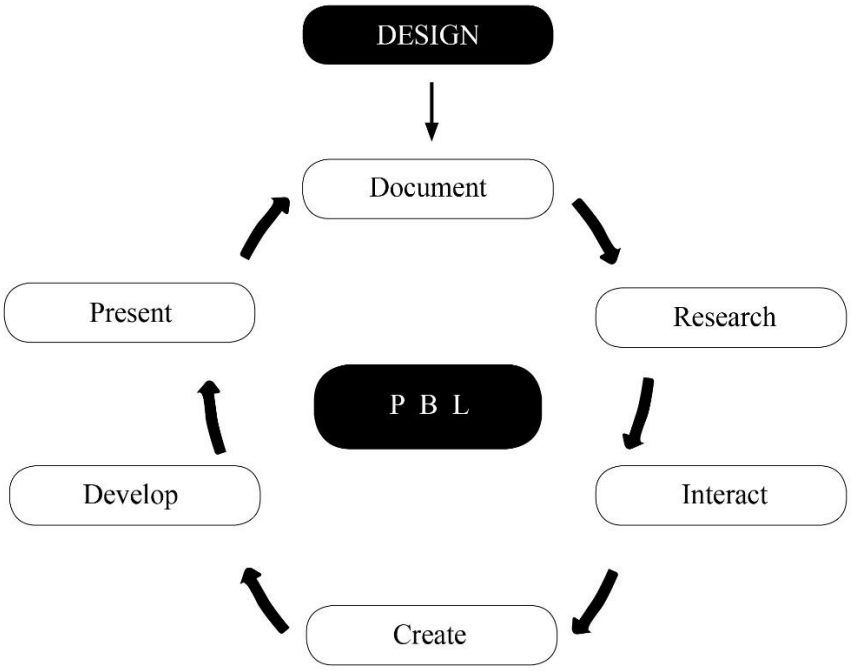

Fig. 2. PBL based in product design.

For its development different educational units such as mathematics, computer science, social science and technical drawing have to be used. For the manufacturing a 3D printer as tool and resources based in new technologies are used.
It is expected that through a process of product design, the students will use new technologies and therefore develop his creative and technical abilities together and applying different areas of knowledge.

5. Results and future research

The practical objective of this case consist on the creation of knowledge within different curricular fields integrated in a disciplinary subject. It is required the development of a new educational methodology based on those previously existent, where new digital fabrication technologies could be integrated into arts and science and technology academic fields.
It is carried out throughout observation and a qualitative assessment of how students have accomplished different design-based challenges and projects over the sessions. In addition, these serve for the analysis and improvement of current and future research:

- The utilization of digital fabrication in education is presented as the resource and tool to perform a STEAM process within education system.
- Based on a design-focused PBL, it allows students explore ways of learning supplementary to the traditional education. Product design produces motivation towards active learning, where problem solving develops cognitive abilities and stimulates creative and critical thinking.
- The implementation of a STEAM learning through a project and using new technologies, creates motivation for learning. Students turn to knowledge acquired from different fields and integrate them into the project. Interest about how things are made and what are they used for increases.
- Through a methodology based on the principles of constructivism, they are able to select multiple variations for the development of the task. This solution searching produces an increase in self-esteem and self-confidence. That increase strengthens knowledge and the 'how to make' concept.
- Students develop working in group skills and, because of the realization of the task, they learn solidarity towards their peers.

Within education framework, a PBL based on design generates the bond to deal with this multidisciplinary paradigm and to be able to take a close look at new educational proposals in order to face the continuous technological changes.
Product designing under a PBL within a STEAM process enables the student to experiment with concepts which can be applied to real life. This arises the interest for new technological tools and their implementation on new personal projects.
It clears a path for new lines of research, in order to study de development of new didactic units and how to face new technologies as a creative learning tool within a STEAM multidisciplinary educational framework.

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